SECTION 1

2002 OZONE PRECURSOR INVENTORY OVERVIEW AND SUMMARY

In 1997, the U.S. Environmental Protection Agency (EPA) promulgated a revised National Ambient Air Quality Standard (NAAQS) for ground-level ozone at a concentration of 0.08 ppm averaged over eight hours. The new standard supersedes the 1-hour ozone standard of 0.12 ppm (EPA, 2005). All three of Delaware's counties (Kent, New Castle, and Sussex) have been designated non-attainment for the 8-hour standard based on 2000-2002 monitoring data. All three counties were included in the Philadelphia-Wilmington-Atlantic City non-attainment area which is listed as a "moderate" area with an attainment date of June 15, 2010 (EPA, 2003). The 8-hour standard went into effect on June 15, 2004 following final non-attainment area boundary designations (EPA, 2004).

EPA established calendar year 2002 as the base year inventory for the new ozone standard (EPA, 2002a), thus requiring states with 8-hour ozone non-attainment areas to submit as part of their State Implementation Plan (SIP) a comprehensive, accurate, and current base year inventory of actual emissions of ozone-causing pollutants from all sources. Ozone-causing pollutants, also known as ozone precursors, include volatile organic compounds (VOCs), oxides of nitrogen (NO_x), and carbon monoxide (CO).

This report documents Delaware's completed 2002 statewide inventory of ozone precursors for all sources including the following five major source sectors: stationary point, stationary non-point, on-road mobile, non-road mobile, and natural.

1.1 Project Management

The Delaware Air Quality Management Section (AQMS) of the Department of Natural Resources and Environmental Control (DNREC) manages Delaware's SIP. The Emission Inventory Development (EID) Program within the Planning Branch of AQMS was responsible for preparing the 2002 base year ozone precursor inventory.

Internal planning began in September 2002, with focus on the 2002 point source inventory reporting cycle taking place in March/April of 2003. Due to a staffing shortage, the EID Program sought contractual assistance for developing the inventory, and in November 2002 began the open bid procurement process. AQMS contracted with E.H. Pechan and Associates (Pechan) based in Durham, North Carolina, who joined the project in August 2003.

1.1.1 Project Manager

The overall project manager was David Fees, Program Manager for the EID Program. Responsibilities included:

- Procuring contractual services to assist inventory effort;
- Managing the contract with Pechan;
- Identifying overall inventory goals, objectives, and deadlines;
- Maintaining the official, approved Quality Assurance Project Plan (QAPP);

- Overseeing the development of the Inventory Preparation Plan (IPP);
- Approving estimation methodologies recommended by staff and the contractor;
- Reviewing emission estimation work;
- Coordinating quality control and quality assurance efforts;
- Conducting project meetings; and
- Ensuring that deadlines were met.

1.1.2 Point Sources Technical Lead

The point source technical planning and review was performed by John Outten, a senior environmental scientist for the EID Program. Responsibilities included:

- Identifying point source inventory goals, objectives, and deadlines;
- Establishing the universe of facilities to inventory;
- Overseeing the development of the survey forms and instructions;
- Providing training and guidance to industry representatives;
- Setting up the on-line electronic reporting system and working with DNREC's Office of Information Technology in preparing the on-line reporting capabilities;
- Performing a technical review of emissions data submitted by facilities;
- Working with facility representatives to correct errors;
- Managing the point source inventory database; and
- Overseeing quality control of point sources data.

1.1.3 Point Sources Support

Support of the point source inventory was performed by Marian Hitch, a senior environmental specialist for the EID Program. Responsibilities included:

- Gathering facility general information on facilities to be surveyed;
- Assisting in developing survey forms and instructions;
- Preparing and mailing reporting packages;
- Receiving and organizing reports submitted by facilities;
- Entering data into the point source inventory database;
- Performing an administrative review of all reports received;
- Tracking reporting status of each facility; and
- Preparing and organizing documentation for the point source inventory.

1.1.4 Contractor Assistance

The project leader for Pechan was Randy Strait, Director of Southeast Operations. Mr. Strait also assisting EID staff with the point source inventory development. Due to staff shortages within EID, Pechan took the lead for developing stationary non-point sources (led by Steve Roe, Senior Scientist), on-road mobile sources (led by Maureen Mullen, Senior Chemical Engineer), and non-road mobile sources (led by Kirstin Thesing, Environmental Scientist). Responsibilities included:

- Establishing the list of source categories in each sector to inventory;

- Establishing prioritization of categories;
- Researching available emission estimation methods and supplying recommendations to the project manager;
- Developing survey instruments for categories to be surveyed;
- Gathering activity data through request letters and other means as was necessary to obtain the data required for the selected methods;
- Developing databases and/or spreadsheets necessary to manage data and calculate emissions;
- Preparing and organizing documentation in support of emission estimates;
- Performing quality control of the data; and
- Ensuring that timelines were met.

1.1.5 Non-point Sources Support

Support of the non-point source inventory was performed by Harry Jeudy, an engineer who joined the EID Program in September 2003. Responsibilities included:

- Assisting Pechan in obtaining activity data;
- Reviewing emission calculations;
- Preparing report documents; and
- Compiling supporting documentation.

1.1.6 Quality Assurance Coordinators

Quality assurance outside the EID Program was conducted by Dr. Frank Gao, senior engineer for the Planning Branch within AQMS, and Philip Wheeler, mobile sources planner for the Planning Branch. Dr. Gao is responsible for developing control strategies for attainment of the 8-hour ozone standard. Mr. Wheeler is responsible for transportation conformity and on-road mobile projection inventories. Both are knowledgeable of VOC and NO_x sources, emission estimation methodologies and controls in their respective areas of expertise.

Quality assurance responsibilities associated with the 2002 inventory included evaluating emission estimation methodologies, reviewing model input and output files, assessing application of controls, rule effectiveness and rule penetration, and reviewing emission totals.

1.2 Inventory Planning

Calendar year 2002 was established not only as the base year for ozone attainment planning, but also as the base year for both fine particulates and regional haze SIP planning. In addition, 2002 was designated by AQMS to include a detailed air toxics inventory in support of dispersion modeling as part of a statewide air toxics assessment study. Finally, in 2002 EPA promulgated the Consolidated Emissions Reporting Rule (CERR), which established new reporting requirements for State and local agencies (EPA, 2002b).

As a result of these several purposes, the 2002 inventory included all criteria pollutants and their precursors (VOC, NO_x, CO, SO_2, PM_{10}-PRI, $PM_{2.5}$-PRI, and NH_3) and all Hazardous Air Pollutants (HAPs) identified in Section 112(b)(1) of the Clean Air Act.

To summarize, the 2002 Delaware air emissions inventory was developed with several purposes in mind. These included a:

- Base year ozone precursor inventory for non-attainment of the 8-hour standard;
- Base year fine particulate and regional haze inventory;
- Modeling inventory for the Delaware Air Toxics Assessment Study (DATAS);
- Milestone demonstration year inventory for the 1-hour ozone standard; and to
- Meet the CERR requirements.

As of June 15, 2005, the 1-hour ozone standard was revoked and replaced by the 8-hour standard. Therefore, milestone demonstrations under the 1-hour standard are no longer required.

With the several purposes for the 2002 inventory identified, the EID Program, with the assistance of its contractor, developed an Inventory Preparation Plan (IPP) for each source sector except natural sources. The source sectors include point sources, non-point sources, on-road mobile sources, and non-road sources. The IPPs identified the following:

- **Data quality needs** – established the level of quality needed to ensure the inventory would meet the several inventory purposes;
- **Inventory parameters** - identified the pollutants to be inventoried, the geographic coverage, and the spatial and temporal resolution;
- **Emission sources** – enumerated all sources within the geographic area that emit one or more of the pollutants to be inventoried;
- **Estimation methodologies** – researched and selected the method to be used for each source category, based on quality of method output, quality and availability of method inputs, importance of category to the overall inventory, and time and resource constraints;
- **Data collection** – identified data collection methods based on estimation methodologies chosen;
- **Data management** – identified data management methods, including data storage, data calculations, and data table outputs;
- **Documentation** – identified the expected level of documentation necessary in support of the inventory; and
- **Quality assurance/quality control (QA/QC)** – established QC procedures to reduce errors and increase the completeness and accuracy of the emission estimates, and established QA procedures to demonstrate that data quality needs had been met.

1.2.1 Data Quality Needs

The development of the modeling inventory for the DATAS project represented the most rigorous and detailed of the several inventories that were developed for 2002. Since criteria pollutant data (i.e., VOCs and particulate matter) were speciated in many instances to arrive at air toxic emissions, the criteria pollutant emissions were developed to the same level of detail as the air toxics. In achieving the data quality needs for DATAS, most requirements for the other purposes were met.

The 2002 ozone precursor inventory as a SIP element represents a Type II inventory per EPA guidance (EIIP, 1997). The inventory will provide support for AQMS planners as they develop control strategies believed necessary to achieve attainment of the 8-hour ozone standard. Percent

reductions as part of progress plans are developed from the base year. For both of these uses, it is important the inventory individually assign emissions to very specific sources (identified by Source Classification Codes, or SCCs) in order to delineate reductions to be gained through implemented control measures.

Data quality needs pertaining to accuracy, completeness, representativeness, and comparability were considered and documented as part of the IPP development process. Special effort was given to the larger point sources and those area sources contributing most significantly to emissions of VOCs and/or NO_x.

Qualitative assessments of accuracy are described in the respective source sector sections of the report. However, quantitative measures of uncertainty (such as the Data Attribute Rating System, or DARS scores) were not employed in the developed of this inventory.

Representativeness was considered a priority of the inventory, as well as an area where AQMS could make a difference. Considerable effort was given to obtaining local activity data (and to a lesser extent, local emission factors) for estimating non-point source emissions. Point source emission thresholds for VOCs and NO_x were established much lower than typical definitions of major sources in order to increase point source backouts within some highly uncertain area source category emission estimates.

Completeness was also considered a priority of the inventory and was best exemplified by a 100% point source reporting rate (after considerable follow-up with some facilities.) Comparability was not considered as much of a priority as it has been in past periodic emission inventories, since this inventory is a base year. AQMS believes the development of a base year inventory represents the best opportunity to apply the most current estimation methods and not be constrained by using methods applied in the past.

1.2.2 Inventory Parameters

The inventory parameters defined by the ozone precursor inventory needs include the following:

- **Inventory year** – the base year inventory is calendar year 2002;
- **Pollutants** – ozone precursors include VOCs, NO_x, and CO;
- **Source coverage** – all sources, including point, stationary non-point, mobile, non-road, and natural sources;
- **Spatial resolution** – for purposes of developing a SIP inventory for ozone precursors, county level emissions for all non-point sources and geocoded point source emissions;
- **Geographic coverage** – since all counties in Delaware are in non-attainment of the 8-hour ozone standard, a statewide inventory was developed; and
- **Temporal resolution** – annual and typical summer season weekday emissions were developed.

EPA issued guidance to state and local agencies indicating that for purposes of meeting the CERR requirements with respect to biogenic emissions, that an agency could accept EPA's development of biogenic emissions in lieu of submitting its own biogenics inventory. AQMS accepted the biogenic emissions as developed by EPA, and is incorporating those emission estimates into this report.

For purposes of this inventory, VOCs and NO_x are defined in Regulation 1101 of the Delaware Regulations Governing the Control of Air Pollution (DNREC, 1993). Only those VOCs that participate in atmospheric photochemical reactions are included in the VOC emissions quantified in this report. Speciated VOC data were obtained from point sources, to verify that the VOC total included only reactive VOCs. The definition of VOCs in Regulation 1101 includes a list of non-reactive and negligibly-reactive compounds.

The typical summer season weekday emissions are based on Delaware's definition of peak ozone season, which is June 1 through August 31. Activity data for point and non-point sources were obtained and developed for each month of the year and/or monthly temporal allocation profiles were developed. Details of temporal resolution development are presented in detail within each source sector section of the report.

1.2.3 Emission Sources and Estimation Methodologies

Previous point and non-point source inventories, the National Emission Inventory, the Emission Inventory Improvement Program (EIIP) emission estimation methodology documents and other reports and studies were used in identifying source categories and methodologies. Particularly for area sources, Pechan often recommended and utilized methods and data from recent work performed by the State of California. Details of the methods used are presented in each source sector section of the report.

Besides removing emissions of non-reactive VOCs from the inventory, emissions from regulated sources, both point and non-point, were adjusted for rule effectiveness and rule penetration, where applicable. Rule effectiveness (RE) reflects the level of compliance with any particular regulation. Rule penetration (RP) represents the percent of sources within a source category that are subject to the rule that requires control.

1.2.4 Data Collection and Management

For all source categories the gathering of local activity data represented a major task spread over many months. For point sources, most facilities reported their emissions through the use of an on-line reporting system. Data entered into the on-line system were transferred to the AQMS *i*-STEPS® database for review and correction.

Microsoft Excel spreadsheets were employed for managing activity data and calculating emissions from stationary non-point sources and some non-road categories. A consistent set of tabs within each source category spreadsheet included activity data, point source data (if applicable, for backouts), emission factors, controls, emission calculations, National Emission Inventory (NEI) input formats, and notes on QA/QC procedures.

On-road mobile source emissions were calculated using the MOBILE6 model. Emissions for most of the non-road vehicles and equipment categories were calculated using the NONROAD model. Emissions data were transferred from *i*-STEPS® (point sources), from the non-point spreadsheets, and from the model outputs to NEI Input Format (NIF) files in Microsoft Access tables. These tables were transmitted to the NEI by June 1, 2004 to meet the reporting requirements of the CERR.

1.3 Inventory Development

Once the IPPs were finalized, the EID Program staff and Pechan began to develop the inventory. For point sources, the EID Program developed a set of criteria to use in establishing the universe of facilities required to report. These criteria are presented in detail in the point source section of this report. Reporting packages were sent to each facility meeting one or more of the reporting criteria. An extensive amount of review and follow up was performed on the point source data submitted by facilities.

For non-point sources, the first main task involved gathering activity data for each source category. In many cases, these data were obtained from Delaware-specific sources. In some cases the activity data were developed through the allocation of a portion of a national activity dataset (i.e., national paint sales) to Delaware. Basic demographic data were also used for some source categories and are presented in Table 1-1. Once activity data were obtained, spreadsheets were developed to manage the data and combine the activity data with the selected emission factors to obtain uncontrolled emissions. Finally, for those sources where controls applied, emissions were adjusted to account for control efficiency, rule effectiveness, and rule penetration.

Table 1-1. 2002 Demographic Data for Delaware

Demographic Parameter	Kent	New Castle	Sussex	Statewide
Population[a]	131,069	512,360	163,946	807,375
Households[a]	49,127	191,787	66,471	307,385
Land Area (square miles)	594	439	950	1,983
Annual VMT (million miles)[b]	1,406	5,338	2,091	8,835

[a] DPC, 2003; [b] DelDOT, 2004.

For several non-point source categories, models were used to develop either emission factors (i.e., MOBILE6) or final emissions (NONROAD). In the use of these models, activity data were included in the model input files. For any type of data used by the model for which Delaware-specific data did not exist, the model used the system defaults. Details about Delaware-specific and default parameters are discussed in the on-road and non-road sections. The models account for controls, some of which reflect controls specific to Delaware.

1.4 Quality Assurance/Quality Control

Quality assurance and quality control were conducted throughout the inventory development process and at multiple levels. For instance, Pechan established a QA/QC tab in each area source spreadsheet. Review by Pechan staff other than those working on the source category and follow-up corrections were documented within the spreadsheet. A second layer of quality control involved the review of all non-point source spreadsheets by the EID project manager. The QA coordinators performed one final review of the activity data, estimation methods, calculations, and emission totals.

1.5 Documentation Organization

This report presents detailed discussions of the emission estimation methods, data sources, and quality control/assurance procedures used to compile the 2002 ozone precursor inventory. At the end of each source category write up is a list of references. The inventory preparation plans,

calculation spreadsheets, model input and output files, QA/QC reports, and other supporting documentation are contained on a CD included in the back sleeve of this report. Much of the documentation that is referenced in the report but not contained on the CD has been compiled in electronic and hard copy files located at the AQMS offices in Dover, Delaware and are available for review by the public.

1.6 Emissions Summary

The following emission summaries present the entire 2002 emission inventory for VOCs, NO_x, and CO, broken down by (1) annual and summer season weekday values, (2) for each of Delaware's three counties, and (3) by source sector. Natural sources are presented separately from anthropogenic sources of emissions. Throughout this document, annual emissions are reported in tons per year (TPY), and summer season weekday emissions are reported in tons per day (TPD). Summer season weekday emissions are also referred to as peak ozone season daily emissions.

1.6.1 Emissions from Anthropogenic Sources

Table 1-2. 2002 Annual and SSWD VOC, NO_x, and CO Emissions by County

County	Annual (TPY)			SSWD (TPD)		
	VOC	NO_x	CO	VOC	NO_x	CO
Kent	5,292	10,314	39,090	16.86	34.50	111.98
New Castle	18,100	30,748	144,691	58.66	107.22	405.47
Sussex	10,278	16,059	64,127	40.02	57.37	190.50
Statewide	**33,672**	**57,122**	**247,909**	**115.53**	**199.08**	**707.94**

Figure 1-1. VOC Summer Daily Emissions by County

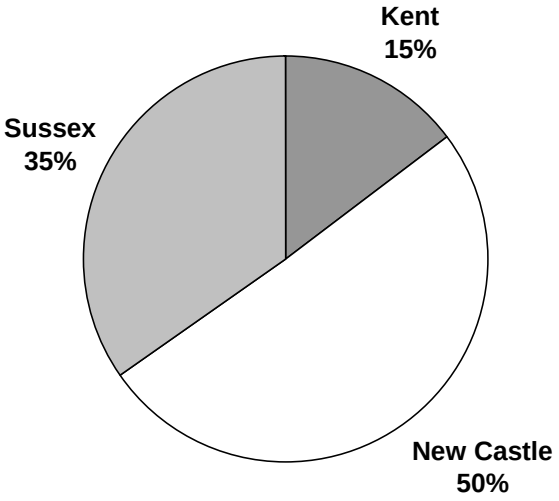

Figure 1-2. NO_x Summer Daily Emissions by County

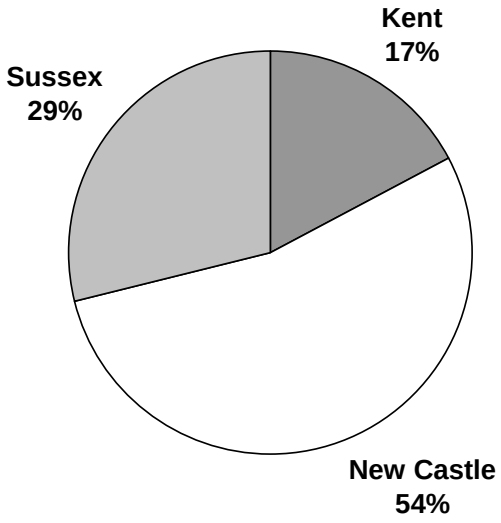

Table 1-3. 2002 Annual and SSWD VOC, NO_x, and CO Emissions by Source Sector

Source Sector	Annual (TPY)			SSWD (TPD)		
	VOC	NO_x	CO	VOC	NO_x	CO
Point	4,773	16,372	9,612	23.31	74.09	36.77
Non-point	10,316	2,427	8,618	33.08	3.17	7.24
On-road	10,564	21,341	160,761	32.37	69.03	396.87
Non-road	8,019	16,982	68,918	26.77	52.79	267.06
All Sectors	**33,672**	**57,122**	**247,909**	**115.53**	**199.08**	**707.94**

Table 1-4. 2002 Kent County Annual and SSWD VOC, NO_x, and CO Emissions by Source Sector

Source Sector	Annual (TPY)			SSWD (TPD)		
	VOC	NO_x	CO	VOC	NO_x	CO
Point	133	1,064	436	0.49	5.06	1.73
Non-point	1,786	359	1,602	5.75	0.45	2.76
On-road	1,737	4,182	25,991	5.45	13.97	66.61
Non-road	1,636	4,709	11,061	5.17	15.02	40.88
All Sectors	**5,292**	**10,314**	**39,090**	**16.86**	**34.50**	**111.98**

Figure 1-3. VOC Summer Daily Emissions by Source Sector

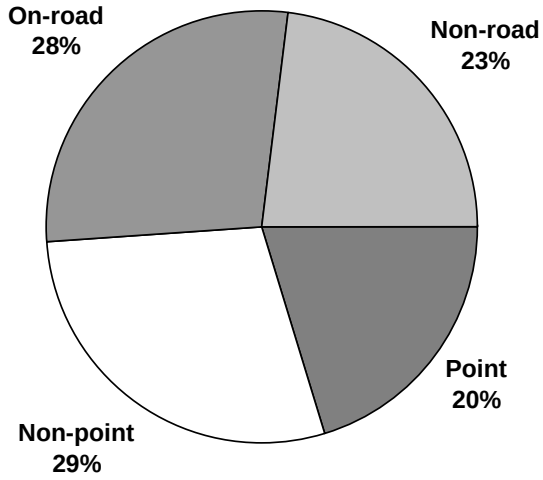

Figure 1-4. NO_x Summer Daily Emissions by Source Sector

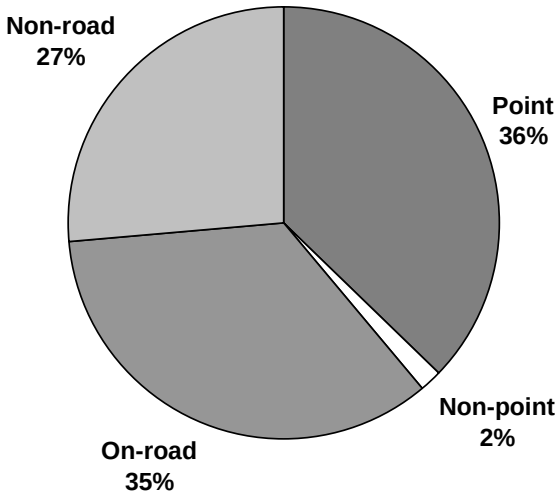

Table 1-5. 2002 New Castle County Annual and SSWD VOC, NO_x, and CO Emissions by Source Sector

Source Sector	Annual (TPY)			SSWD (TPD)		
	VOC	NO_x	CO	VOC	NO_x	CO
Point	2,687	9,157	8,530	9.42	44.09	32.60
Non-point	6,236	1,513	4,194	20.02	1.95	2.10
On-road	5,762	11,799	93,358	16.98	36.56	217.37
Non-road	3,415	8,279	38,609	12.24	24.62	153.40
All Sectors	**18,100**	**30,748**	**144,691**	**58.66**	**107.22**	**405.47**

Table 1-6. 2002 Sussex County Annual and SSWD VOC, NO_x, and CO Emissions by Source Sector

Source Sector	Annual (TPY)			SSWD (TPD)		
	VOC	NO_x	CO	VOC	NO_x	CO
Point	1,952	6,151	645	13.40	24.95	2.44
Non-point	2,293	554	2,822	7.31	0.77	2.38
On-road	3,065	5,360	41,412	9.95	18.50	112.89
Non-road	2,968	3,994	19,248	9.36	13.15	72.79
All Sectors	**10,278**	**16,059**	**64,127**	**40.02**	**57.37**	**190.50**

1.6.2 Emissions from Natural Sources

Table 1-7. 2002 Annual and SSWD VOC, NO_x, and CO Emissions for Natural Sources by County

County	Annual (TPY)			SSWD (TPD)		
	VOC	NO_x	CO	VOC	NO_x	CO
Kent	9,139	251	886	60.76	1.27	5.18
New Castle	6,332	159	636	42.92	0.81	3.87
Sussex	11,109	354	1,272	70.26	1.78	7.03
Statewide	**26,580**	**764**	**2,794**	**173.94**	**3.86**	**16.08**

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